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ABSTRACT

In research, the use of linear additive methods is expedient when prediction is the goal; however, when understanding is the goal, an exploration of non-linear multiplicative procedures is more appropriate. To compare the results of linear and non-linear models, data obtained from a survey of 35 bereaved mothers were compared using scattergrams, correlational analyses, analysis of variance, and factorial plots. Independent variables in the study included length of time since the death, the mother's level of education, her perception of family religiosity, and family stress. The dependent variable was maternal perception of family adaptation to the unexpected death of a child. Results showed that analysis based only upon correlation coefficents was misleading since this approach did not account for the disordinal interactions indicated by the Anova. These findings suggest that research and theory on family adaptation to crisis, based only on additive linear information, could misdirect family practitioners and counselors. Researchers must be careful to define their goals, conduct exploratory data analyses, and use non-linear models when theory is not strong, in order to derive the most beneficial and "true" results from their data. (Author/BL)

Misuse of Linear Models: Understanding Community Linkages in Family Adaptation to Unexpected Death

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Abstract

Anderson and Shanteau (1977) have suggested that the goal of research can be either prediction or understanding. The use of linear additive methods is expedient when one's goal is prediction; however, when understanding is the goal an exploration of non-linear multiplicative procedures is more appropriate. This paper provides two examples for comparing the results of linear and non-linear models. Data were obtained from a survey of 35 bereaved mothers. Independent variables include length of time since the death, the mother's level of education, her perception of family religiosity, and family stress. The dependent variable is maternal perception of family adaptation to the unexpected death of a child. Results were compared using scattergrams, correlational analyses, analysis of variance and factorial plots. Analysis based only upon correlation coefficients was misleading since this approach did not account for the disordinal interactions indicated by the Anova. Implications for theory, research and application are discussed in relation to both bereaved families and family studies in general.

Misuse of Linear Models: Understanding Community Linkages in Family Adaptation to Unexpected Death

Anderson and Shanteau (1977) have suggested that the goal of research can be either prediction or understanding. Their work indicates that these two goals are often incompatible, each imposing its own constraints on design and procedure. If the goal of research is prediction then linear models are useful, owing in part to their simplicity and ability to gloss over discrepancies that appear in part of the data.[1] However, if the goal of research is understanding, then the use of correlational analysis and examination of additive models can be extremely misleading. This can be crucial when theory calls for interaction effects and only linear models are tested. Schumm (1982) has suggested that it is possible for interaction effects to be of such importance that proper interpretation of the relationship between two variables cannot be done without accounting for such interaction terms.

It is our concern that the growing use of multivariate analyses in family studies (Miller, Rollins, and Thomas, 1982) will lead to naive application of linear procedures without careful consideration of both data inspection procedures and non-linear models. This position echoes the concerns of others who claim that social scientists need both a skepticism of multivariate and summary measures that represent only certain aspects of the complexities of data, and an openness to unanticipated patterns through more exploratory data analyses (Hartwig and Dearing, 1979; Schumm, 1982). Hartwig and Dearing (1979) have attributed this problem of naive application of summary procedures in part to the false equation of data analysis with

statistics. While data analysis involves the breakdown of data into meaningful components, it has been taken to mean the analysis of data by use of statistics alone, minimizing the importance of visual displays of data.

The confusion over whether the goal of one's research is prediction or understanding, together with the choice of inappropriate or limited data analysis methods not only is a hinderance to methodology in family studies but affects the entire profession. While several authors have called for an integration of theory, research and application (Olson, 1976; Sprenkle, 1976) this objective cannot be reached through incomplete or incorrect analysis of data. Differentiation of the goals of prediction and understanding in family studies along with clarity of their statistical and data analysis problems may be a step toward enhancing the quality of research, aiding theory construction and enabling educators and clinicians to address issues of the practical applications of our works.

The main thrust of this paper is to provide two examples of the forementioned problems by comparing visual display of raw data with linear and non-linear models in the area of family adaptation to crisis, focusing on community linkages and their possible relationships to adaptation. Specifically, this paper focuses on factors related to maternal perception of family adaptation to the unexpected death of a child. Although several authors have indicated that families face great difficulty after the death of a child (Kubler-Ross, 1969; Schiff, 1977), research findings available are generally case studies based on clinical observations of dysfunctional families (Hilgard, 1974; Krell and Rabkin, 1979) or involve families who have experienced a child's death due to a fatal illness (Hare-Mustin, 1979; Kalish, 1977; Shrier, 1980). While the majority of deaths of infants,

children, adolescents, and young adults result from sudden and unexpected causes (Nixon and Pearn, 1977), there is a lack of information concerning the post-death situations of these families. Therefore, it is assumed that theory concerning family adaptation to the unexpected death of a child is inadequate for conducting studies aimed at prediction and that the goal of related research at this point is to increase understanding rather than enhance predictive ability.

Methods

All families contacted were involved with The Compassionate Friends, a nationwide nondenominational self-help organization for bereaved parents. One hundred seventy-six questionnaires were distributed to parents at meetings of four Compassionate Friends groups located in three metropolitan areas in northeast Ohio. Subjects returned questionnaires by mail or at the next monthly meeting of a Compassionate Friends group. Fifty questionnaires were returned for a 28% response rate, typical of this type of research (see Videka-Sherman, 1982). Of those 50 questionnaires, 35 were returned by mothers who experienced the sudden unexpected death of a child.

The mothers' average age was 41 and ranged from 26 to 58. Nearly half of the mothers had attended college. Eighty-three percent were currently married. Sixteen mothers identified themselves as Protestant, 15 as Roman Catholic, 2 as nondenominational and 2 as having no religious preference.

The major dependent variable survied in this project was the mother's perception of personal and family coping following the sudden unexpected

death of a child. A sudden death was defined as one which occurred within 24 hours of the cause or accident. Coping was defined as the response of individual family members to manage the hardships of the situation (McCubbin and Patterson, 1981, 1982). The scale for measuring perceived coping was obtained from a set of objective criteria developed by Swarner (1980). The criteria were developed from open-ended questions used to study the adaptation level of parents following the fatal illness of a child. The criteria were translated into a set of 15 likert scale items.

Four major independent variables were assessed. Three were drawn from concepts implicit in McCubbin and Patterson's Double ABCX Model (1981,1982). Stress was measured using the Life Events Inventory (Cochrane and Robertson, 1973), a checklist of events designed to measure the amount of turmoil and upheaval that the family incurred within the past year. For the Anova, stress scores were rank ordered and categorized as "high" (n=17) or "low" (n=18). Religiosity, defined as family religious participation, behaviors and attitudes, was determined by 9 items used in the Gallop Poll (Religion in America, 1975). For the Anova, religiosity scores were rank ordered and categorized as "high" (n=17) or "low" (n=18). Education was assessed by mothers' responses concerning their highest level of education, which ranged from 10 to 21 years. For the Anova, education scores were rank ordered and categorized as "12 years or less" (n=19) or "greater than 12 years" (n=16).

Although the fourth variable, time, is not explicit in the Double ABCX Model it is listed as an important implicit dimension since McCubbin and Patterson expected that as families proceeded through the coping process, more of them would move toward higher levels of Bon Adaptation. Time since

the child's death was collapsed to form three categories: "less than one year" (n=12), "one to two years" (n=11) and "more than two years" (n=12).

Results

Preliminary

Results of the bivariate correlation analysis on original undichotomized data (see Table 1) indicated that stress (r=-.32) and education (r=.43) were significantly correlated only with adaptation while religiosity (r=.26) and time (r=.17) were not. Anderson and Shanteau (1977) have noted that when understanding is the ultimate goal (as in this case), the use of correlations may produce an inaccurate picture. Therefore, scattergrams of points representing the relationship of stress and education with adaptation scores were constructed (see Figures 1 and 2). The neat linear patterns anticipated from the correlations were not observed. There appeared a definite group of scores that clustered away from the dominant pattern in each case.

Example 1

Following Swarner's (1980) approach, adaptation scores were rank ordered and categorized as "high" (n=17) or "low" (n=18). A correlation analysis (see Table 2) indicated that the coefficients for time (r=.07), religiosity (r=.20) and mother's education (r=.14) with perceived family adaptation were positive but not significant. The coefficient between stress and adaptation (r=-.37) was negative and significant.

Using the suggestion of Anderson and Shanteau (1977) an analysis of variance was computed to aid understanding (see Table 3). The analysis of variance indicated that the main effect for stress on adaptation was not

significant at the .05 level. However, the interaction terms for stress by religiosity and stress by education were significant.

The interaction of stress and religiosity as it affected adaptation was plotted in Figures 3 and 4. Both factorial plots indicate a disordinal interaction (Kennedy, 1978). The combination of high stress and low religiosity was related to low perceived family adaptation. The adaptation of families with high stress was significantly influenced by level of religiosity (Figure 3), and adaptation of families with low religiosity was significantly influenced by level of stress (Figure 4). For low stress families, level of religiosity did not greatly influence adaptation (Figure 3) as was true for the influence of level of stress on the adaptation of families with high religiosity (Figure 4).

A similar disordinal pattern of interaction was noted in the factorial plots of the relationship of level of stress and mother's education to adaptation (Figures 5 and 6). Perceived adaptation was lowest among families with high stress and a low level of mother's education. High perceived adaptation occurred in families where either there was a low level of stress and a low level of mother's education or where there was high stress and a high level of mother's education.

Example 2

Assuming that Swarner's (1980) decision to dichotomize families as either high or low adapters was arbitrary and did not necessarily accurately describe the adaptation of bereaved families, the same analyses were run using the original range of adaptation scores. Results of the bivariate correlation analysis (Table 4) resembled those of the original undichotomized data (see Table 1). Only stress ($r=-.41$) and education ($r=.48$) were

significantly correlated with perceived adaptation.

Again, to aid understanding of the situation of bereaved families, an analysis of variance was computed (see Table 5). This analysis indicated that the main effects of stress and education were significant, as was the interaction of stress and education. Kennedy (1978) has suggested that if main effects and interaction are each significantly related to a dependent variable then a factorial plot is necessary to clarify the findings. If the interaction is ordinal then summary statements can be made of the overall main effects. However, if there is a disordinal interaction this negates simple interpretation of main effects, and conclusions regarding the relative effectiveness of independent variables must be specific to each level or combination of interacting variables. Figure 7 indicates that the interaction of stress and education is disordinal. Therefore, interpretation of the simple main effects from either the Anova or the bivariate correlations is misleading. As was found in Example 1, the combination of low education and high stress was related to low perceived adaptation. Figure 8 plots education as a function of levels of stress. This figure indicates that highest perceived adaptation occurred in families where mothers had higher levels of education (suggesting a main effect). If the factorial plot is graphed with levels of education in its face (as in Figure 8) then the presence of a disordinal interaction is obscured. While the choice of which factor to graph in the face of a factorial plot is up to the researcher in predictive research (because there presumably is a variable of greatest interest), research that is aimed at increased understanding necessitates the graphing of both plots.

Discussion

Reiterating the ideas of Anderson and Shanteau (1977), this paper is not intended to criticize the use of linear additive models in research conducted with the goal of practical prediction. However, when the goal of research is understanding, linear additive models gloss over discrepancies in the data that can provide important clues. Other authors have highlighted this point. Lichtenstein, Earle, and Slovic (1975: 85) noted that correlations derived from regression models are "not useful in uncovering serious discrepancies from the model."[2] The statistician John Tukey (1969: 89) has gone so far as to say that "Sweeping things under the rug is the enemy of good data analysis (and) using the correlation coefficient is 'sweeping under the rug' with a vengeance." What is needed in research aimed at understanding is a test for the degree of disagreement between model and data, rather than a test for the degree of agreement (Anderson and Shanteau, 1977).

Improperly conducted research can not only produce inaccurate results, but on a cumulative basis it can produce harmful effects on the direction of research, perpetuating incomplete or incorrect information.[3] In addition to misguiding research, the work of other family professionals would be affected. Research that is guided by the goal of prediction alone would limit the comprehensive nature of theory used by family life educators. Although such a theory may predict the adaptation level of a certain type of family, it ignores the life experiences and needs of many other families.

Research and theory on family adaptation to crisis, based only on additive linear information (such as that contained in correlation examples within this paper), could also misdirect family practitioners and counselors. For example, the linear additive model would suggest that

simply minimizing stress would lead to higher perceived family adaptation. Ignoring the interaction of stress with such resources as level of education or religiosity results is an incomplete and simplistic prescription. It appears that for some families the combination of high stress pile-up and a high level of resources (or community linkages) can result in higher than average adaptation.

Clarity and understanding are particularly important for professionals involved in death education or working with bereaved families. There is a general lack of thanatological education and training among family professionals. This void is also perpetuated within textbooks on marriage and the family where little space has been used to deal with familial coping with death -- a crisis which all families will encounter (Dickinson and Fritz, 1981). Attention to this issue, the use of exploratory data analyses and examination of non-linear models may aid in understanding the interactions of stress pile-up, family resources and family perceptions (or definitions) and their role in adaptation. For example, it appears that the interaction of level of stress and mother's education influences adaptation. In this case, is education a resource (such as a contributor of social supports), a cognitive framework for organizing and interpreting stressor events (Videka-Sherman, 1982), or both? The same question can be asked of the role of religiosity and stress. Why is it that certain combinations of stress and resources appear to foster adaptation to crisis while other combinations seem to inhibit adaptation? What aspects of religiosity or education are most helpful in adaptation? When issues such as these are more clear, then practicioners will be better equipped to aid bereaved families, policymakers can more efficiently distribute resources and accountability will be less nebulous.

In summary, although the findings presented here are not conclusive,

they serve to suggest that: 1) prior to conducting a study researchers determine whether their goal is one of prediction (i.e., "Do the data confirm my hypothesis?") or understanding (i.e., "What can these data tell me about the relationship between these variables?"), 2) exploratory data analyses, including visual displays such as scattergrams, be conducted to get an initial "feel for the data", and 3) when theory is not strong and/or understanding is the goal of research then non-linear and multiplicative models be included, with an examination of factorial plots. For non-linear analyses the use of analysis of variance or regression with built-in interaction terms may be useful. Log linear analyses can be conducted as a way to use a multiplicative model for regression.

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Footnotes

1 According to Marsden the use of a linear model implies that the effect of raising an independent variable by one of its units is constant with changes on the dependent variable. The nature of this relationship depends neither on the value of the dependent variable before the change nor on the value of any other independent variable (1981: 14). The term "linear model" in this paper will include the use of correlational analysis (Pearson's correlational coefficient) and those regressions which examine only main effects. In contrast, non-linearity will refer to examples in which the effects of an independent variable on a dependent variable are not constant (Marsden, 1981).

2 Although the analysis of variance employed in this paper is a special case of regression, it goes beyond analysis of a linear additive model by examining non-linearity and multiplicative or joint relations (Kennedy, 1978; Pedhazur, 1982).

3 The reader may be questioning whether the plotting of residuals would clarify research aimed at understanding and exploration. Anderson and Shanteau (1977) have shown several scatterplots of predicted values as a function of the observed means, with correlations above .98. Yet, each of these plots is misleading -- concealing the bilinear fan shape of factorial plots which support a multiplicative model.

Table 1: Pearson's Correlation Matrix

(with no variables dichotomized)

(n=35)

	Time	Stress	Religiosity	Education
Adaptation	.170	-.324*	.264	.430*
Time		-.085	-.129	.149
Stress			-.018	-.123
Religiosity				.263

*$p \leq .05$

Table 2: Pearson's Correlation Matrix

(with all variables dichotomized)

(n=35)

	Time	Stress	Religiosity	Education
Adaptation	.069	-.373*	.199	.141
Time		-.138	0.000	.069
Stress			-.144	-.089
Religiosity				.141

*$p \leq .05$

Table 3: Anova for Education, Stress and Religiosity on Family Adaptation

(All variables dichotomized)

Source	df	SS	MS	F
Education (E)	1	.195	.195	1.114
Stress (S)	1	.630	.630	3.593
Religiosity (R)	1	.329	.329	1.877
E x S	1	1.149	1.149	6.555*
E x R	1	.368	.368	2.102
S x R	1	.877	.877	5.004*
E x S x R	1	.014	.014	0.081
Residual	27	4.733	.175	
Total	34	8.743	.257	

*$p \leq .05$

Table 4: Pearson's Correlation Matrix

(Only independent variables dichotomized)

(n=35)

	Time	Stress	Religiosity	Education
Adaptation	.168	-.409*	.143	.484*
Time		-.138	0.000	.069
Stress			-.144	-.088
Religiosity				.141

*$p \leq .05$

Table 5: Anova for Education, Stress and Religiosity on Family Adaptation (only independent variables dichotomized)

Source	df	SS	MS	F
Education (E)	1	286.608	286.608	12.181*
Stress (S)	1	191.090	191.090	8.121*
Religiosity (R)	1	1.007	1.007	0.043
E x S	1	196.801	196.801	8.364*
E x R	1	2.567	2.567	0.109
S x R	1	53.391	53.391	2.269
E x S x R	1	2.446	2.446	0.104
Residual	27	635.293	23.529	5.038
Total	34			

*$p \leq .05$

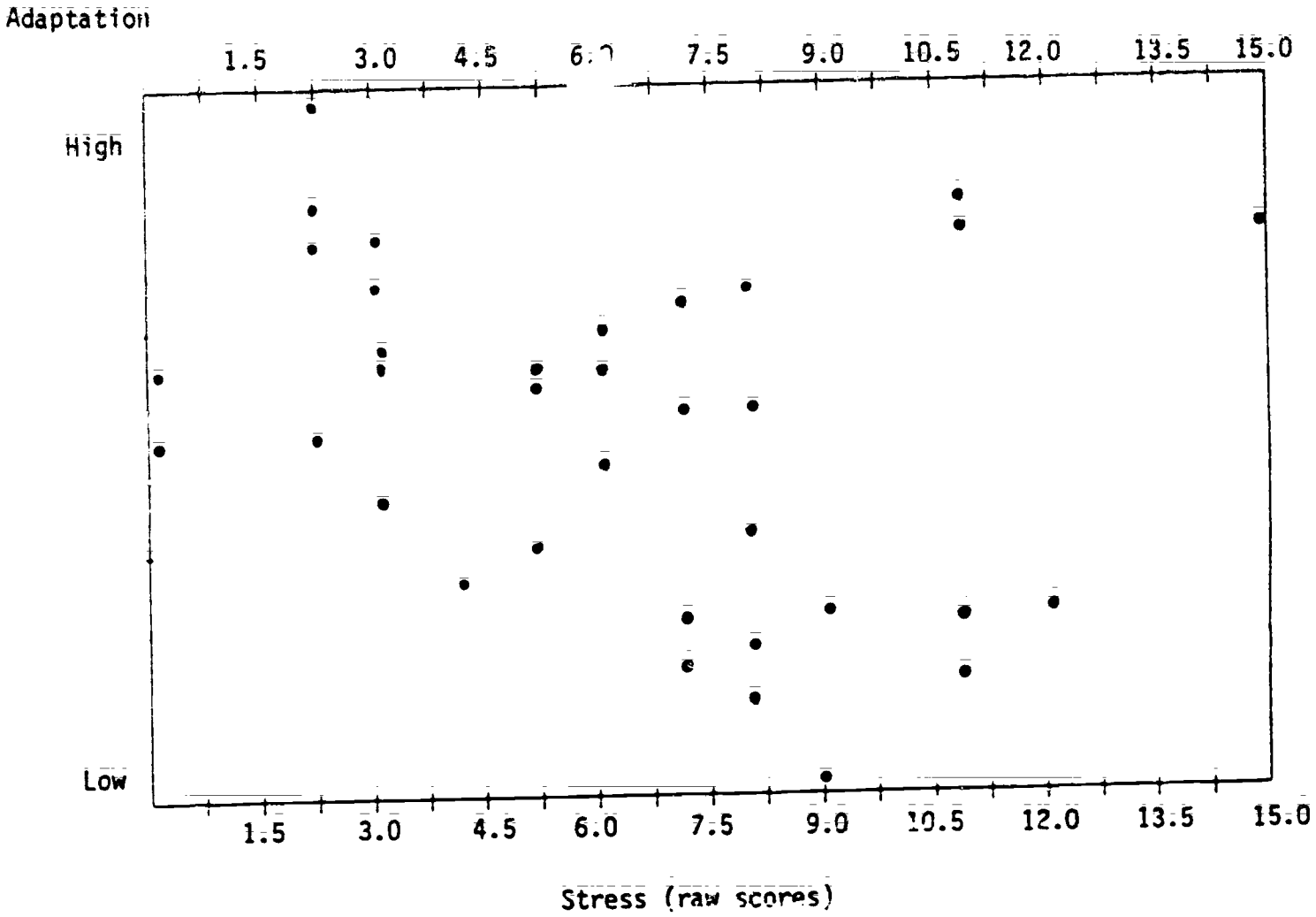

Figure 1. Scattergram of adaptation by stress.

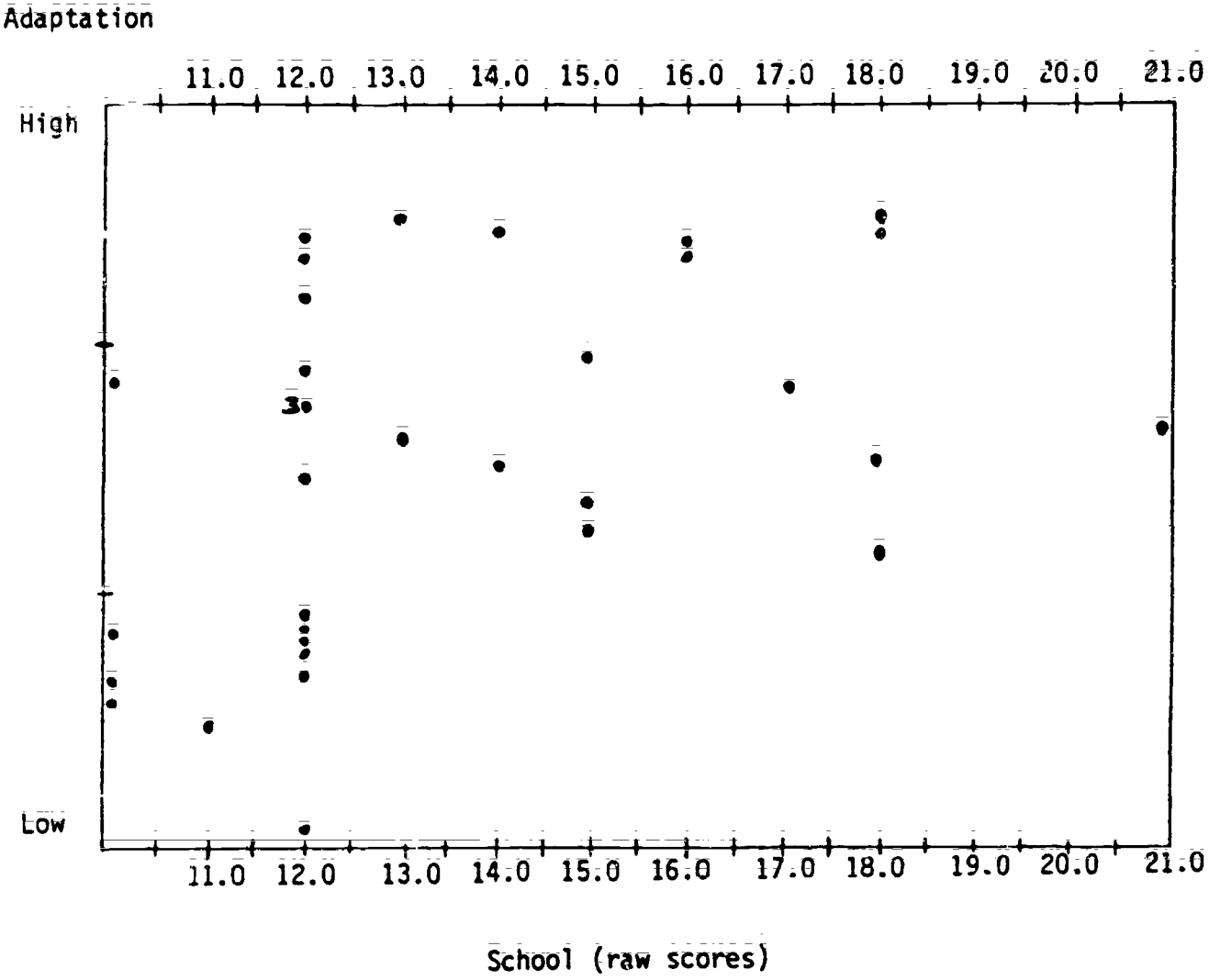

Figure 2. Scattergram of adaptation by school.

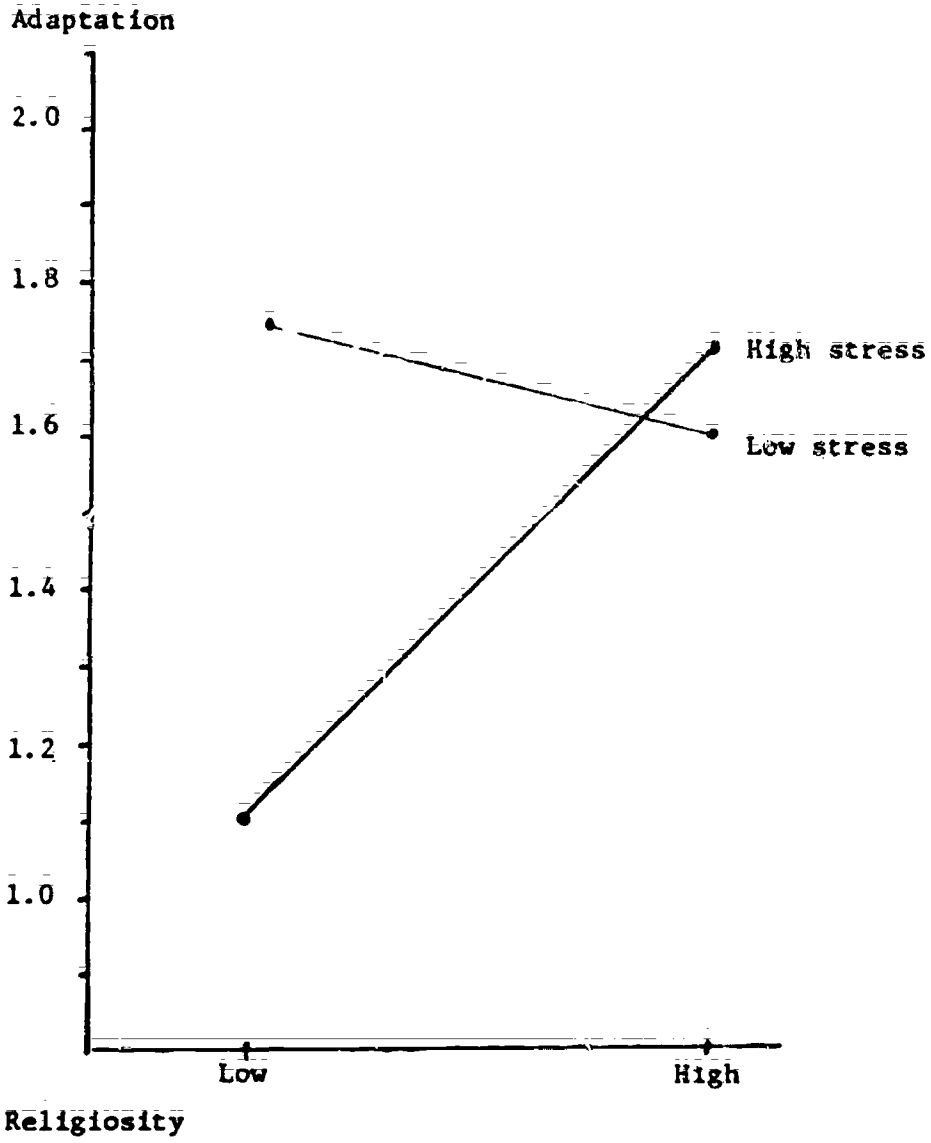

Figure 3: Effect of Stress and Religiosity on Adaptation*
(stress as a function of levels of religiosity)

*Adaptation dichotomized

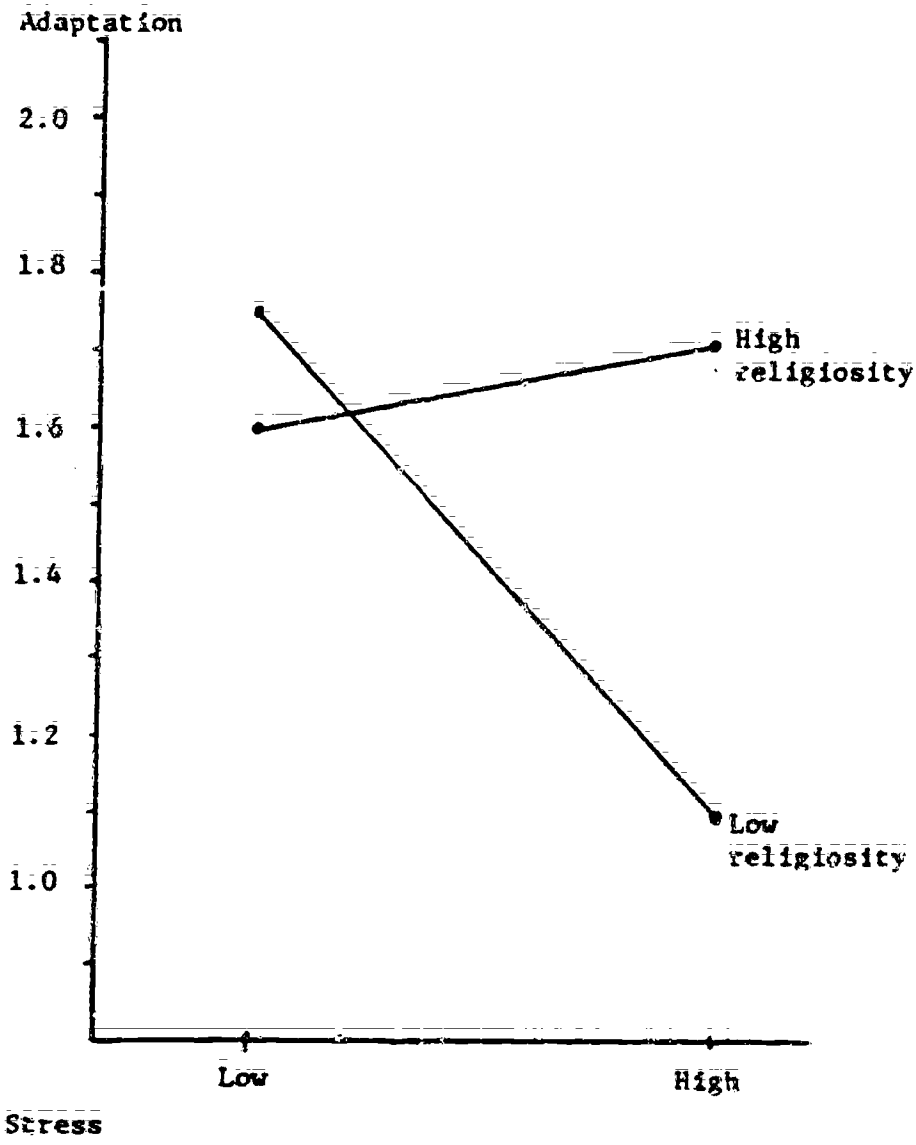

Figure 4: Effect of Stress and Religiosity on Adaptation*
(religiosity as a function of levels of stress)

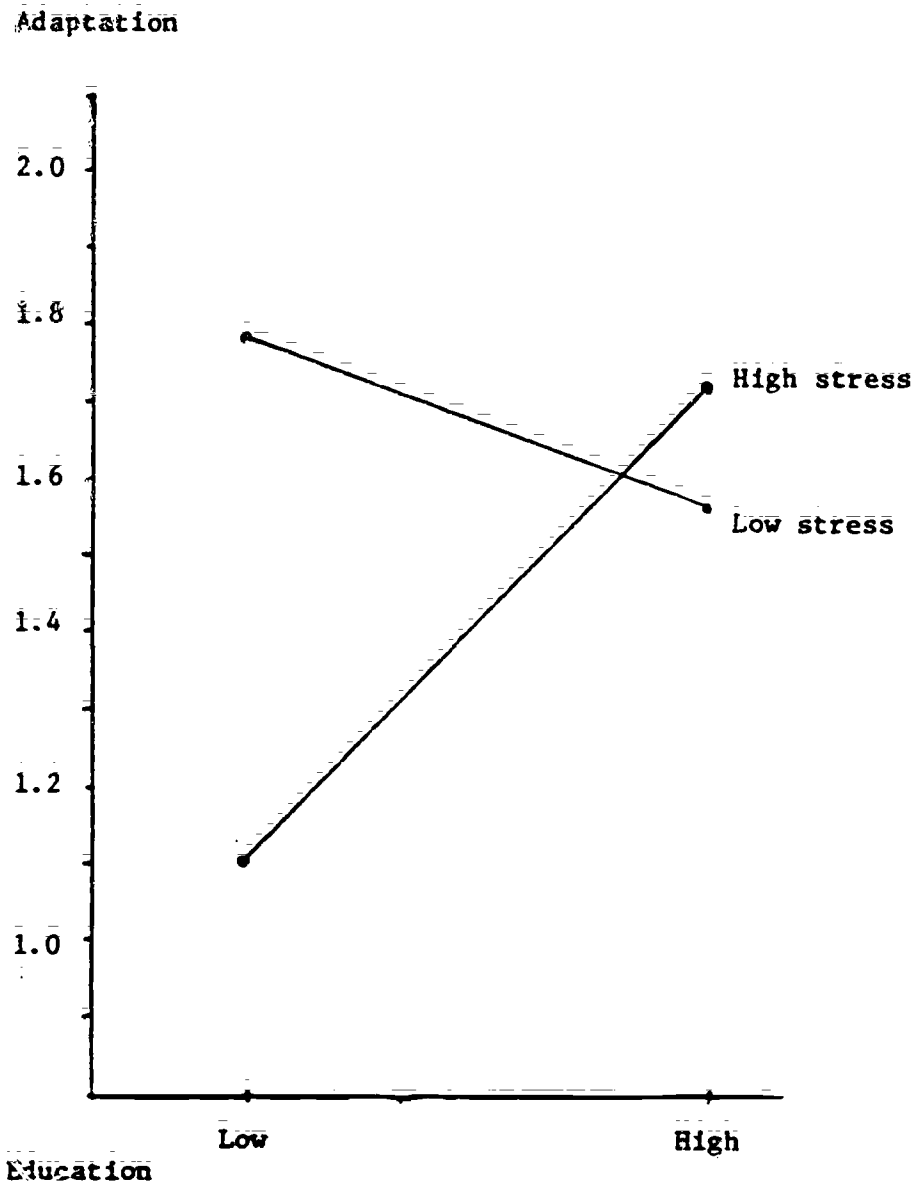

Figure 5: Effect of Stress and Education on Adaptation*
(stress as a function of levels of education)

*Adaptation dichotomized

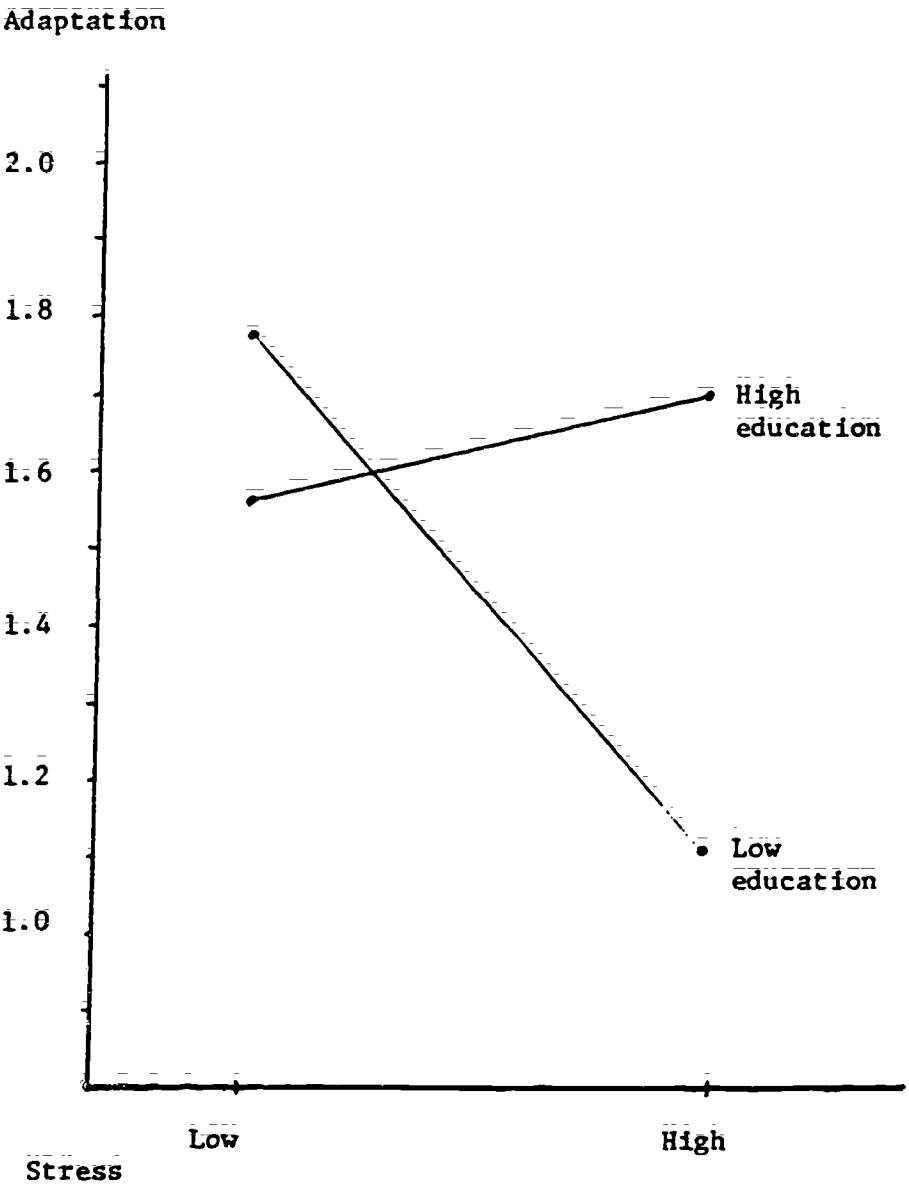

Figure 6: Effect of Stress and Education on Adaptation*
(education as a function of levels of stress)

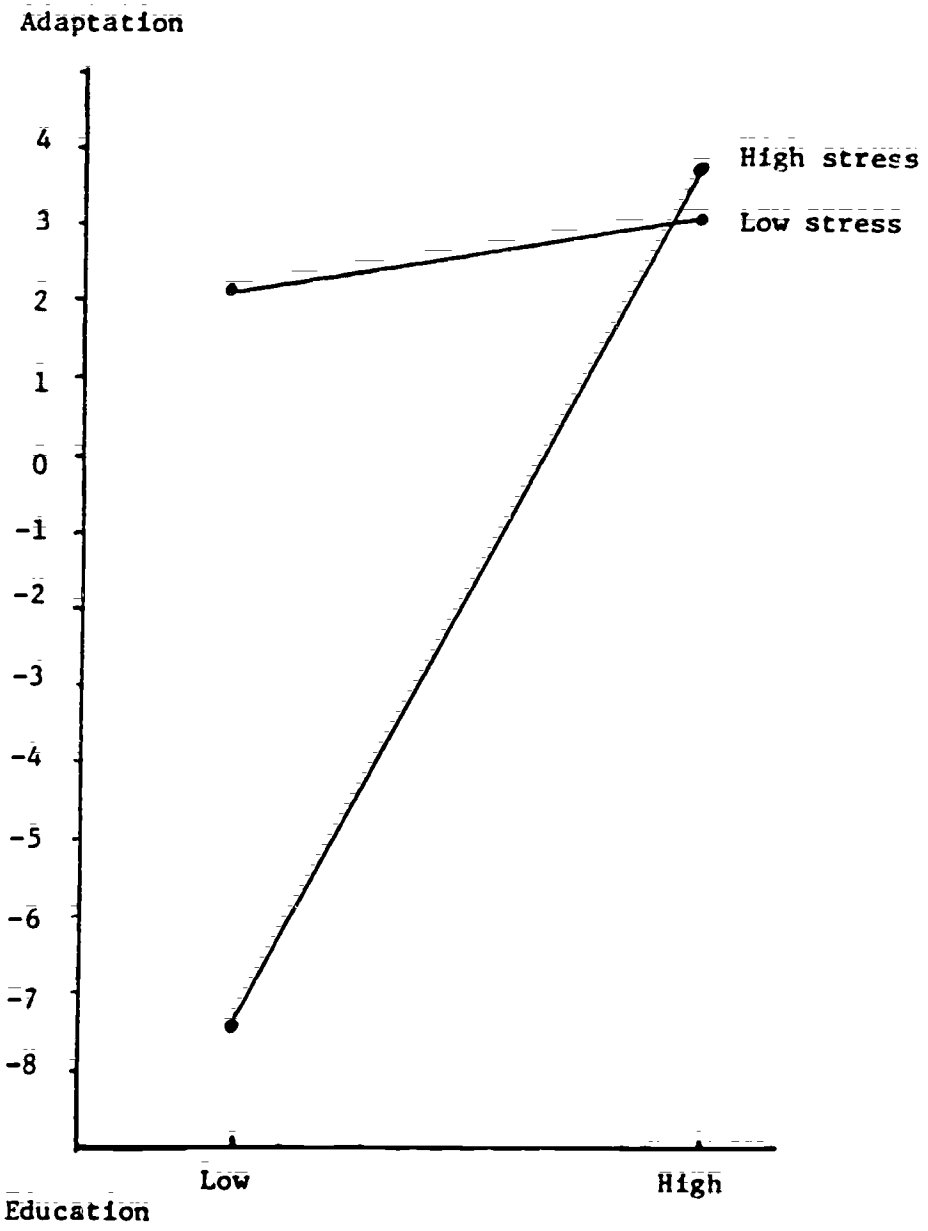

Figure 7: Effect of Stress and Education on Adaptation *
(stress as a function of levels of education)

*Adaptation not dichotomized

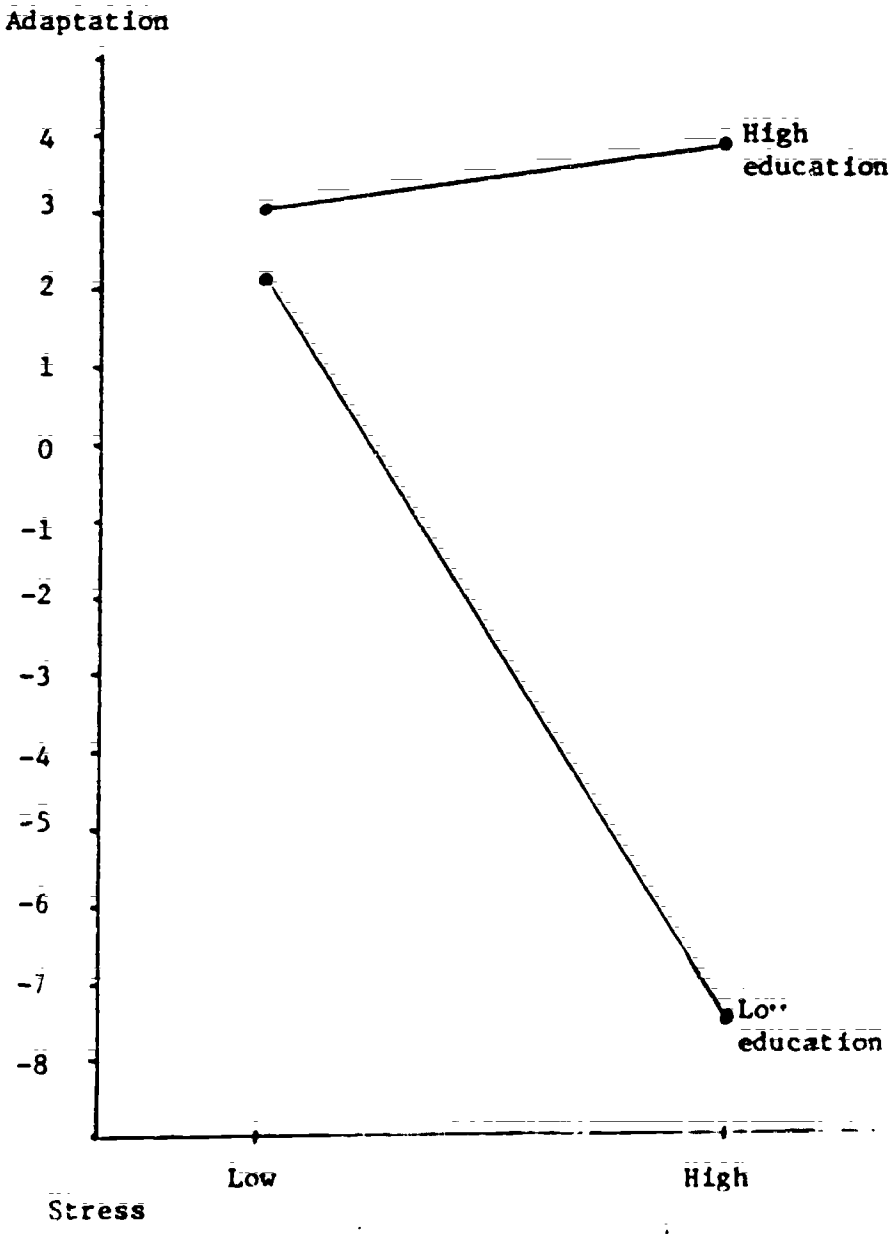

Figure 8: Effect of Stress and Education on Adaptation * (education as a function of levels of stress)